ABSTRACT

The invention provides semiconductor materials including a gallium nitride material layer formed on a silicon substrate and methods to form the semiconductor materials. The semiconductor materials include a transition layer formed between the silicon substrate and the gallium nitride material layer. The transition layer is compositionally-graded to lower stresses in the gallium nitride material layer which can result from differences in thermal expansion rates between the gallium nitride material and the substrate. The lowering of stresses in the gallium nitride material layer reduces the tendency of cracks to form. Thus, the invention enables the production of semiconductor materials including gallium nitride material layers having few or no cracks. The semiconductor materials may be used in a number of microelectronic and optical applications.